



## ASSESSMENT OF SCALLOPS (*PLACOPECTEN MAGELLANICUS*) IN SCALLOP PRODUCTION AREAS 1 TO 6 IN THE BAY OF FUNDY

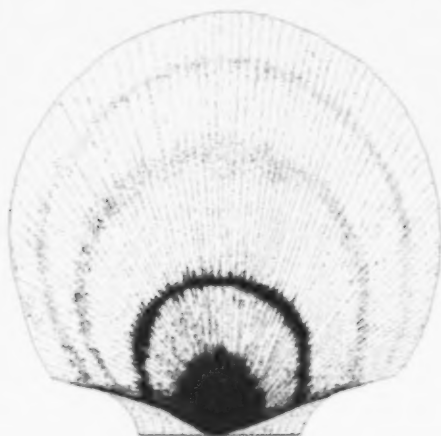


Image: *Placopecten magellanicus*.



Figure 1. Scallop Production Areas (SPAs) in the Bay of Fundy. Refer to full detail map in Appendix 1 for place names.

### Context:

The Bay of Fundy area is fished by three scallop fleets: the Full Bay Fleet, the Mid Bay Fleet, and the Upper Bay Fleet. Full Bay license holders are permitted to fish throughout the Bay of Fundy. Mid Bay license holders have access to all areas north of the Mid Bay line. Upper Bay licence holders are restricted to the upper reaches of the bay. The fishery has been managed using limited entry, gear size limits, seasonal closures, minimum shell height, and meat count. The gear width limit is 5.5 m with a ring size of not less than 82 mm inside diameter. Quotas were introduced in 1997. The Full Bay Fleet operates under an Individual Transferable Quota (ITQ) system, while the Mid and Upper Bay fleets fish with competitive quotas. Total Allowable Catches (TACs) are set and landings are reported in terms of meat weights (adductor muscles).

Scallops in Scallop Production Areas (SPAs) 1 to 6 in the Bay of Fundy are assessed according to a framework conducted in 2002 (DFO 2002).

This Science Advisory Report is from the November 6-7, 2013, Assessment of Bay of Fundy Scallop. The objectives of this meeting were to: (1) assess the status of scallop stocks by SPA (SPA 1A, subareas of SPA 1B, SPA 3, 4, 5, and 6), taking into account available commercial and survey information, and (2), using proposed reference points, harvest strategies and indicators, evaluate the consequences of different harvest levels during the 2013/2014 fishery on stock abundance, exploitation rate, and interim harvest levels for 2014/2015. In addition, provide interim advice for SPA 1A, 1B, 3 and 4 for the start of the 2014/2015 season. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

## SUMMARY

### General

- Models used in this assessment have been reviewed previously; however, one change was made in 2013 to include sample variances from the survey time series in the observation models.
- The standard harvest scenario tables used to provide Total Allowable Catch (TAC) advice now include probabilities associated with being above the Lower Reference Point (LRP) and Upper stock reference (USR) point. The USRs presented here were used for illustrative purposes and were based on methods developed for an industry/DFO working group. Formal adoption of USRs will be finalized through discussions with the Inshore Scallop Advisory Committee in the coming year.

### SPA 1A

- The Full Bay Fleet caught a total of 206 t against a TAC of 200 t during the 2012/2013 fishery in Scallop Production Area (SPA) 1A.
- Commercial catch rates in 2012/2013 increased from the 2011/2012 fishing season to 20.5 kg/h, above the long-term median (1995/1996 to 2011/2012) of 15.3 kg/h.
- Recruit (65-79 mm) abundance and biomass decreased slightly in 2 to 8 mile area, but increased in the other areas of SPA 1A. The abundance of commercial scallop ( $\geq 80$  mm) in the survey has been stable in all areas of SPA 1A since 2005. Pre-recruits ( $<65$  mm) scallops were present in all areas of SPA 1A, with the greatest abundance in the 8 to 16 mile area.
- Condition factor ( $\text{g}/\text{dm}^3$ ) has increased in SPA 1A over the last two years, and all areas are above their respective long-term means (1997 to 2012).
- Population biomass estimated by the model was 1,607 t (meats) in 2013, up from the estimate of 1,231 t for 2012 which was approximately equal to the median biomass of 1,206 t (1997 to 2012).
- Catches up to 287 t for 2013/2014 are projected to be at or below a reference exploitation rate of 0.15. The current population biomass is above the LRP of 480 t and the proposed USR (1000 t).

### SPA 1B

- The total 2012/13 landings for all fleets in SPA 1B was 422.9 t against a combined TAC of 375 t.
- In Scallop Fishing Areas (SFAs) 28B and 28D, catch rates almost doubled for the Full Bay Fleet. The Mid Bay Fleet had increases of over 50% in both areas fished, and Upper Bay Fleet had an increase of 62% in 28D and 42% in 28C.
- Recruit biomass from the survey increased in all subareas with the highest increase in SFA 28B. Survey estimates of commercial biomass increased in SFAs 28B, 28C, and 28D. Pre-recruits were seen in all subareas, but the highest abundances were in the Cape Spencer area.
- Condition factor had increased in all subareas of SPA 1B since 2011. Most subareas are at a high in the survey time series.
- Population biomass estimated by the model was 2,635 t (meats) in 2013, a substantial increase from the estimate of 1,757 t for 2012 and well above the median biomass of 1,798 t (1997 to 2012).

- Catches up to 500 t for 2013/2014 are projected to be at or below the reference exploitation rate of 0.15 and are projected to result in an increase in biomass. The current population biomass is above the LRP of 880 t and the proposed USR (1800 t).

## SPA 2

- This area is considered to be marginal habitat for scallops and is not monitored regularly. SPA 2 was last assessed in 2006 (DFO 2007).

## SPA 3

- Total landings for the 2012/2013 fishing season were 261 t against a TAC of 260 t.
- Commercial catch rates in 2013 for St. Mary's Bay increased 26% from 2012, while June catch rates for the Brier/Lurcher area did not change.
- The abundance of recruit scallops decreased in 2013 in all parts of SPA 3. Survey indices indicate increases in commercial biomass in St. Mary's Bay and the Inside area of Brier/Lurcher. Pre-recruits were seen in very large abundances in both the Inside and Outside areas of Brier/Lurcher.
- The best condition was observed in St. Mary's Bay, which increased in 2013 after two years of decline, but condition increased in the other areas as well.
- Population biomass estimated by the model was 1,606 t (meats) in 2013, an increase from the estimate of 1195 t for 2012, and well above the long-term median (1996-2012) biomass of 1,008 t.
- Catches up to 300 t for 2013/2014 are projected to be at or below the reference exploitation rate of 0.15 and are projected to result in an increase in biomass. The current population biomass is above the LRP of 600 t and the proposed USR (1000 t).

## SPA 4

- Total landings in 2012/2013 fishing season were 109.4 t against a TAC of 110 t.
- Commercial catch rates increased in 2013, from 15 to 20 kg/h, and are currently above the long-term median.
- The survey estimate for number of recruits did not change in 2013 and are still at low levels, and absent from a lot of the area. Numbers of commercial scallop have been relatively stable in this area since 2005. In 2013, the commercial biomass increased, mainly due to increases in condition. Pre-recruits were observed in SPA 4 at the highest levels since 2007.
- Condition in this area increased in 2013 and is well above the mean and among the highs in the time series.
- Population biomass estimated by the model was 1,041 t (meats) in 2013, an increase of 33% from the estimate of 782 t in 2012. Estimated recruitment in 2013 is 17 t, below the long-term median of 38 t. Recruitment has been below the long-term median since 2008.
- Catches up to 160 t for 2013/2014 are projected to be at or below the reference exploitation rate of 0.15 and are projected to result in a decrease in biomass. The underlying reason for this decline appears to be the low recruitment since 2008. The current population biomass is above the LRP of 530 t and the proposed USR (750 t).

## SPA 5

- Total landings in 2013 were 5.7 t against a TAC of 10 t.
- Commercial catch rate (19.7 kg/h) increased from 2012, and is above the long-term median (18.6 kg/h).
- The annual survey was discontinued as of 2009 in this SPA.
- Since 2006/2007, the average annual catch has been 6.5 t and the average catch rate has been 16.1 kg/h
- Reference points and TAC advice have not been developed for SPA 5 because this area will be managed with SPA 4 starting with the 2013/2014 fishing season.

## SPA 6

- Total landings for Full Bay and Mid Bay fleets in the 2013 fishing season were 125.6 t against a TAC of 140 t.
- Catch rates for the Mid Bay Fleet increased in all subareas of SPA 6 relative to the lower than average rates in 2012.
- Condition in SPA 6 increased in 2013 for 6A and 6B, and decreased in 6C. However, 6C still has the best condition relative to other subareas of SPA 6.
- Survey estimates of commercial numbers and biomass increased in both SPA 6A and 6B in 2013, but showed no change in 6C. Abundance of recruits increased in all subareas, and pre-recruits were observed in all subareas.
- Catch and effort trends for this area suggest that at the current exploitation level (i.e., mean effort levels), population numbers are close to equilibrium levels with biomass fluctuations subject more to changes in condition than to overall increases or decreases in numbers. It is not known if this equilibrium corresponds to a maximum catch situation.
- The TACs set in this area since 1997 have varied reflecting average catch trends in recent years and were not based on an assessment model or any other indicator of productivity. The current total TAC of 140 t has been in place since 2007.
- The commercial catch rate series starting in 1997 has been proposed as the stock status indicator for this area. The lowest catch rate in the series of 6.2 kg/hr (1997) has been proposed as the LRP for SPA 6.

## BACKGROUND

The Bay of Fundy scallop fisheries have a long and well documented history of peer reviewed assessments, and the assessment approach has been accepted in previous advisory meetings. Models used in this assessment have been reviewed previously; however, one change was made in 2013 to include sample variances from the survey time series in the observation models following methods from Smith and Hubley (2013). This change improves the population estimates by including survey estimates of precision into the assessment model. In previous assessments of these Scallop Production Areas (SPAs), catch levels for the following year had been evaluated for the modeled populations in terms of an exploitation rate target of 0.15, and whether or not the proposed catch would result in a decrease in biomass from the current year. The main goal for this approach was to promote stability in the population biomass until recruitment levels had improved. Recruitment success seems to be determined more by favourable environmental conditions than stock size for scallops. The definition and implementation of reference points and harvest control rules is the subject of ongoing discussions between the industry and Fisheries and Oceans Canada (DFO) to satisfy DFO's sustainable fisheries framework. To date, the fishing industry has agreed to set the Lower



Reference Points (LRP) to the lowest biomass in the time series from which a sustained recovery occurred for those areas with an assessment model (SPA 1A, 1B, 3 and 4). A method to determine Upper Stock Reference points (USRs) based on the equilibrium biomass and exploitation rate associated with maximum catch for the modeled areas was agreed upon in meetings with industry. The mean catch estimated from this method is highly dependent upon recruitment assumptions and should only be interpreted as a relative measure. The standard harvest scenario tables used to provide Total Allowable Catch (TAC) advice now include probabilities associated with exceeding the LRP and USR. The USRs presented here were used for illustrative purposes and were based on methods developed for an industry/DFO working group. Formal adoption of USRs will be finalized through discussions with the Inshore Scallop Advisory Committee (ISAC) in the coming year.

## ASSESSMENT, CONCLUSIONS, AND ADVICE

### SPA 1 – Inner/Upper Bay of Fundy

SPA 1 covers most of the mid to inner Bay of Fundy. Since 2002, it has been managed as two separate areas: SPA 1A and SPA 1B (Appendix 1). The Full Bay Fleet can fish throughout SPA 1A and 1B. However, the other fleets are restricted to SPA 1B, the Mid Bay Fleet fishing only north of the Mid Bay line, and the Upper Bay Fleet fishing only east of the Upper Bay line.

### SPA 1A – Southwest Bay of Fundy

#### Fishery

The Full Bay Fleet caught a total of 206 t against a TAC of 200 t during the 2012/2013 fishery in SPA 1A (Figure 2). For the 2013/2014 fishing season an interim quota of 150 t was set for October 1, 2013. As of November 4, 2013, 6.6 t landings were reported.

Commercial catch rates in 2012/2013 increased from the 2011/2012 fishing season to 20.5 kg/h, above the long-term median (1995/1996 to 2011/2012) of 15.3 kg/h. Effort decreased to below the long-term median.

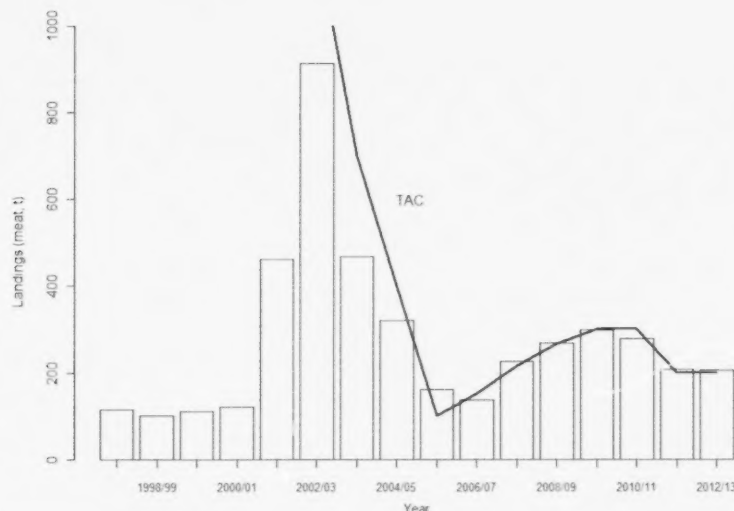


Figure 2. SPA 1A landings (meats, tons) by the Full Bay Fleet. TAC is indicated by the black line.

### Assessment

Recruitment to the fishery in this SPA 1A has been low since the above average 1998 year class entered the fishery. This year, recruit (65-79 mm) abundance and biomass decreased slightly in 2 to 8 mile area, but increased in the other areas of SPA 1A. The abundance of commercial scallop ( $\geq 80$  mm) in the survey has been stable in all areas of SPA 1A since 2005. In 2013, there was no substantial change in commercial abundance in any of the areas. Pre-recruits ( $<65$  mm) scallops were present in all areas of SPA 1A, with the greatest abundance in the 8 to 16 mile zone. Condition factor ( $\text{g/dm}^3$ ) has increased in SPA 1A over the last two years, and all areas are above their respective long-term means (1997 to 2012). Improvements in condition in Middle Bay South and 8 to 16 mile area have resulted in increases in the biomass of commercial scallops in the survey.

The population model described in Smith and Lundy (2002), with modifications described in Smith et al. (2012b), was applied to the combined survey biomass data for the three surveys in this area along with the catch data over the 1997 to 2013 period. Population biomass estimated by the model was 1,607 t (meats) in 2013, up from the estimate of 1,231 t for 2012 which was approximately equal to the median biomass of 1,206 t (1997 to 2012). Estimates of recruit biomass increased from 79 t in 2012 to 152 t in 2013, which is above the long-term median level of 65 t.

The equilibrium analysis derived from model simulations for the next 50 years shows that exploitation rates near 0.15 results in the highest median catches, while fishing at lower exploitation rates result in a higher median biomass. An USR of 1000 t produced the highest median catch (205 t) with a median biomass of 1087 t.

### Conclusions and Advice

Catches up to 287 t for 2013/2014 are projected to be at or below the reference exploitation rate of 0.15 (Table 1). Catches at or below an exploitation of 0.15 are expected to result in an increase in biomass, with no change in biomass projected at 300 t (0.16). The current population biomass is above the LRP of 480 t and the proposed USR (1000 t). Biomass estimates in this area usually fall near to or within the 50% credible interval, but the 2012 prediction for 2013 biomass was somewhat lower than this year's estimate. This was largely due to an unexpected increase in condition.

*Table 1. Harvest scenario table for SPA 1A to evaluate 2013/2014 catch levels in terms of resulting exploitation (e), expected changes in biomass (%), probability of biomass decline, probability that after removal the stock will be above the USR, and above the LRP. These calculations assume a USR of 1000 t and a LRP of 480 t. Potential catches in 2014/2015 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.*

2013/2014						$Pr(e_{2014/2015} \geq 0.15)$					
Catch (t)	e	% Change	Pr Decline	Pr > USR	Pr > LRP	0.1	0.2	0.3	0.4	0.5	0.6
150	0.08	9.94	0.33	0.97	>0.99	201	237	264	289	316	344
175	0.09	7.76	0.36	0.97	>0.99	199	233	260	285	311	339
200	0.10	6.45	0.39	0.97	>0.99	196	229	255	281	306	334
225	0.12	4.77	0.41	0.96	>0.99	193	226	252	276	302	329
250	0.13	2.94	0.44	0.96	>0.99	191	223	249	272	297	325
275	0.14	1.11	0.48	0.95	>0.99	187	218	244	268	293	321
287	0.15	0.37	0.49	0.94	>0.99	186	217	242	267	291	317
300	0.16	-0.47	0.51	0.94	>0.99	184	215	241	264	288	314
325	0.17	-1.75	0.54	0.94	>0.99	182	213	238	262	286	312
350	0.18	-3.63	0.57	0.93	>0.99	179	210	234	257	282	308
375	0.20	-4.87	0.60	0.92	>0.99	175	206	230	253	276	302

## SPA 1B – Northern/Upper Bay of Fundy

### Fishery

In 2007/2008, a TAC sharing formula for the three fleets in SPA 1B was implemented that allocated shares by the three subareas: Scallop Fishing Area (SFA) 28B (excluding SPA 6), SFA 28C, and SFA 28D (Appendix 1). The Full Bay Fleet caught a total of 202.8 t against a TAC of 190.315 t in 2012/2013. An interim quota of 125 t was set for October 1, 2013, for the Full Bay 2013/2014 season and as of November 4, 2013, 36.9 t had been landed. In 2013, the Mid Bay Fleet caught 162.7 t against a TAC of 133.95 t, and the Upper Bay Fleet caught 57.4 t against a TAC of 50.735 t (Figure 3). The total 2012/2013 landings for all fleets in SPA 1B was 422.9 t against a combined TAC of 375 t.

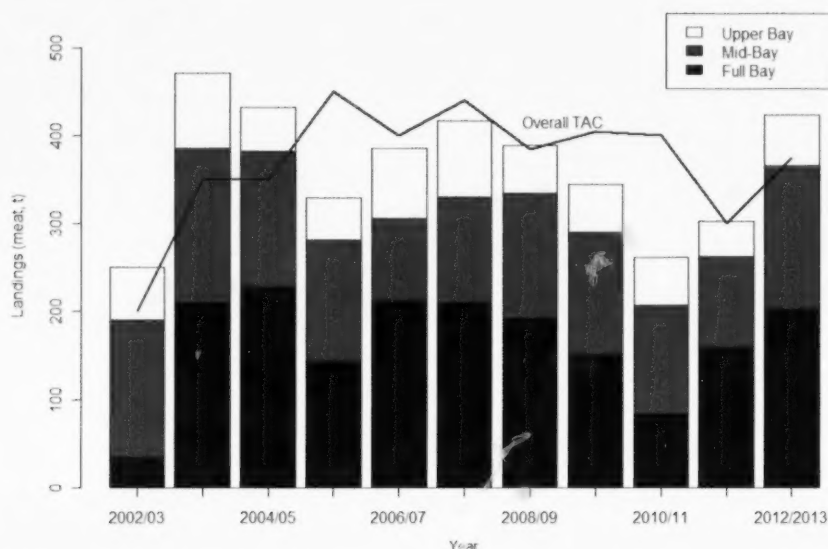


Figure 3. SPA 1B landings (meats, tons) by the Full Bay Fleet (black), Mid Bay Fleet (blue), and Upper Bay Fleet (white). Combined TAC for the three fleets is indicated by the black line.

### Assessment

Catch rates increased for all fleets fishing in SPA 1B. In SFAs 28B and 28D, catch rates almost doubled for the Full Bay Fleet. The Mid Bay Fleet had increases of over 50% in both areas fished, and the Upper Bay Fleet had an increase of 62% in 28D and 42% in 28C.

The survey index of commercial scallop numbers increased or stayed the same in all parts of SPA 1B, except the Outer and Scots Bay areas of 28D, which decreased. Survey estimates of commercial biomass increased in SFAs 28B, 28C, and 28D. Recruit biomass from the survey increased in all subareas with the highest increase in 28B. Pre-recruits were seen in all subareas, but the highest abundances were in the Cape Spencer area. Condition factor had increased in all subareas of SPA 1B since 2011. Most subareas are at a high in the survey time series.

The population model described in Smith and Lundy (2002), with modifications described in Smith et al. (2012b), was applied to the combined survey biomass data and the catch data over the 1997 to 2013 period. Population biomass estimated by the model was 2,635 t (meats) in 2013, a substantial increase from the estimate of 1,757 t for 2012 and well above the median biomass of 1,798 t (1997 to 2012). Estimates of recruit biomass decreased slightly from 580 t in 2012 to 449 t in 2013, but it remains well above the long-term median level of 134 t.

The equilibrium analysis derived from model simulations for the next 50 years shows that exploitation rates near 0.15 results in the highest median catches, while fishing at lower exploitation rates result in a higher median biomass. An USR of 1800 t specifically produced the highest median catch (356 t) with a median biomass of 1937 t.

### Conclusions and Advice

Catches up to 500 t for 2013/2014 are projected to be at or below the reference exploitation rate of 0.15 and are projected to result in an increase in biomass (Table 2). The probability that biomass would decline at this level of catch is 0.35. Most biomass estimates fall within the 50% credible interval of the prediction from the previous year. The current population biomass is above the LRP of 880 t and the proposed USR (1800 t).

Table 2. Harvest scenario table for SPA 1B to evaluate 2013/2014 catch levels in terms of resulting exploitation (e), expected changes in biomass (%), probability of biomass decline, probability that after removal the stock will be above the USR, and above the LRP. These calculations assume a USR of 1800 t and a LRP of 880 t. Potential catches in 2014/2015 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.

Catch (t)	2013/2014					$Pr(e_{2014/2015} \geq 0.15)$					
	e	% Change	Pr Decline	Pr > USR	Pr > LRP	0.1	0.2	0.3	0.4	0.5	0.6
300	0.09	16.91	0.25	0.94	>0.99	347	413	472	530	588	653
350	0.10	15.90	0.27	0.93	>0.99	345	412	469	524	579	644
400	0.12	13.26	0.30	0.92	>0.99	336	405	461	515	569	634
450	0.13	11.05	0.33	0.92	>0.99	333	397	453	504	559	622
500	0.15	9.39	0.35	0.90	>0.99	328	392	444	498	555	618
550	0.16	6.90	0.39	0.89	>0.99	319	381	436	489	546	607
600	0.18	5.15	0.42	0.88	>0.99	314	378	431	483	537	596
650	0.19	3.27	0.45	0.87	>0.99	305	372	425	474	529	591
675	0.20	1.79	0.47	0.86	>0.99	305	367	419	471	526	584

### SPA 3 – Brier Island, Lurcher Shoal, and St. Mary's Bay

#### Fishery

Although scallops can be found throughout most of this area, there are three main beds; those around Lurcher Shoal, below Brier Island, and in St. Mary's Bay. St. Mary's Bay (formerly SPA 7) was included with SPA 3 for a combined TAC starting in 1999.

Total landings for the 2012/2013 fishing season were 261 t against a TAC of 260 t (Figure 4). An interim TAC of 130 t was set for the 2013/2014 fishing season, and 135.6 t had been landed by October 21, 2013, when the fishery was closed pending the assessment.



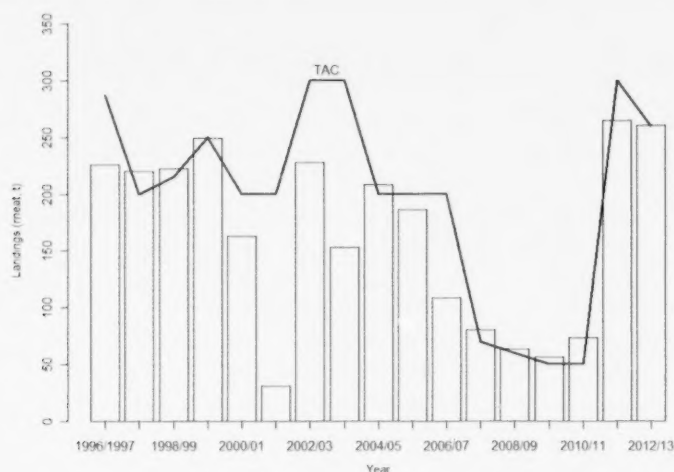


Figure 4. SPA 3 landings (meats, tons) by the Full Bay Fleet. TAC is indicated by the black line.

### Assessment

Commercial catch rates in 2013 for St. Mary's Bay increased 26% from 2012, while June catch rates for the Brier/Lurcher area did not change.

The 2012 survey of SPA 3 used Miracle drags (2 ft × 1 ft) each with 5 2-inch teeth and 3 1/4 inch rings in a nine-gang configuration (Smith et al. 2012a). Industry representatives at the 2012 science peer review meeting criticized the use of toothed gear in SPA 3 and recommended changing the gear for the 2013 survey to flat bar (no teeth). The 2013 survey of SPA 3 was carried out with flat bar gear but included 15 comparative tows between gear with and without teeth. Catches between the two gear configurations were similar enough within the variation observed that survey indices calculated using the tows from either configuration would not result in different estimates of stock status.

As in 2011 and 2012, the 2013 survey area outside of St. Mary's Bay was partitioned according to areas being regularly fished since 2002, and separate survey indices have been developed for these areas, referred to as "Inside" and "Outside." The best condition was observed in St. Mary's Bay, which increased in 2013 after two years of decline, but condition increased in the other areas as well. Survey indices indicate increases in commercial biomass in St. Mary's Bay and the Inside area of Brier/Lurcher. There was an increase in the survey index of commercial numbers in the Inside area, a decrease in the Outside area and no change in St. Mary's Bay. The abundance of recruit scallops decreased in 2013 in all parts of SPA 3. Pre-recruits were seen in very large abundances in both the Inside and Outside areas of Brier/Lurcher. Generally, if pre-recruits of these shell sizes survive in significant numbers, it will be in the Inside area, which has more suitable habitat.

The population model described in Smith and Lundy (2002), with modifications described in Smith et al. (2012b), was applied to the survey biomass data and the catch data over the 1996 to 2013 period. The 2013 population model only used survey data from St. Mary's Bay and the "Inside" area. Population biomass estimated by the model was 1,606 t (meats) in 2013, an increase from the estimate of 1195 t for 2012, and well above the long-term median (1996-2012) biomass of 1,008 t. The estimate of recruit biomass for 2013 was 149 t, similar to what it was in 2012 (147 t) and well above the long-term median level of 47 t.

The equilibrium analysis derived from model simulations for the next 50 years shows that exploitation rates near 0.15 results in the highest median catches, while fishing at lower

exploitation rates result in a higher median biomass. An USR of 1000 t specifically produced the highest median catch (206 t) with a median biomass of 1,092.

### Conclusions and Advice

Catches up to 300 t for 2013/2014 are projected to be at or below the reference exploitation rate of 0.15 and are projected to result in an increase in biomass (Table 3). The probability that biomass would decline at this level of catch is 0.39. The current population biomass is above the LRP of 600 t and the proposed USR (1000 t).

*Table 3. Harvest scenario table for SPA 3 to evaluate 2013/2014 catch levels in terms of resulting exploitation (e), expected changes in biomass (%), probability of biomass decline, probability that after removal the stock will be above the USR, and above the LRP. These calculations assume a USR of 1000 t and a LRP of 600 t. Potential catches in 2014/2015 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.*

2013/2014						Pr(e <sub>2014/2015</sub> ≥ 0.15)					
Catch (t)	e	% Change	Pr Decline	Pr > USR	Pr > LRP	0.1	0.2	0.3	0.4	0.5	0.6
200	0.10	14.26	0.31	0.95	>0.99	200	247	284	320	356	395
225	0.11	12.42	0.32	0.95	>0.99	197	242	279	312	348	387
250	0.12	10.85	0.35	0.95	>0.99	196	240	276	310	344	384
275	0.13	8.84	0.38	0.94	>0.99	192	235	270	304	337	377
300	0.15	7.22	0.39	0.93	>0.99	190	232	265	298	332	372
325	0.16	4.96	0.43	0.93	0.99	185	229	262	295	330	369
350	0.17	3.37	0.45	0.92	0.99	182	223	256	289	321	358
375	0.18	2.07	0.47	0.90	0.99	178	219	254	285	320	357
400	0.20	-0.13	0.50	0.90	0.99	176	217	250	282	314	349

## SPA 4 – Digby

### Fishery

The SPA 4 fishing season extends from October 1 to April 30. Total landings in 2012/2013 fishing season were 109.4 t against a TAC of 110 t (Figure 5). An interim TAC of 80 t was set for the 2013/2014 fishing season. As of the Quota Cap report of November 4, 2013, 18.9 t had been landed.

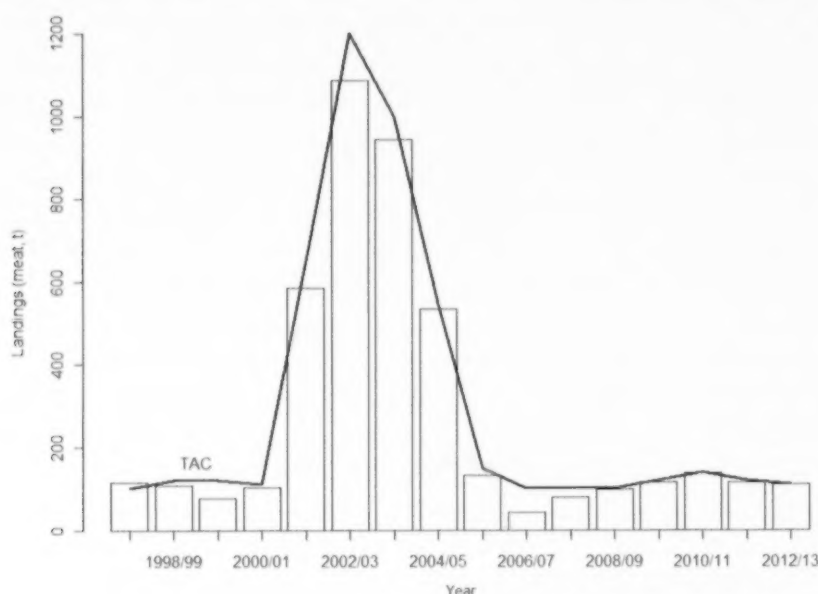


Figure 5. SPA 4 landings (meats, tons) by the Full Bay Fleet. TAC is indicated by the black line.

### Assessment

Commercial catch rates increased in 2013, from 15 to 20 kg/h, and are currently above the long-term median. Since 2006/2007, fishing effort has been below the long-term median, and in 2013 it decreased by about 800 hours.

Condition in this area increased in 2013 and is well above the mean and among the highs in the time series. Numbers of commercial scallop have been relatively stable in this area since 2005. In 2013, the commercial biomass increased from 1.7 to 2.3 kg/tow, mainly due to increases in condition. The survey estimate for number of recruits did not change in 2013 and are still at low levels, and absent from a lot of the area. Pre-recruits were observed in SPA 4, at the highest levels since 2007.

The population model described in Smith and Lundy (2002), with modifications described in Smith et al. (2012b), was applied to the survey biomass data and the catch data over the 1983–2013 period. Population biomass estimated by the model was 1,041 t (meats) in 2013, an increase of 33% from the estimate of 782 t in 2012. Estimated recruitment in 2013 is 17 t, below the long-term median of 38 t. Recruitment has been below the long-term median since 2008.

The equilibrium analysis derived from model simulations for the next 50 years shows that exploitation rates near 0.15 results in the highest median catches, while fishing at lower exploitation rates results in a higher median biomass. An USR of 750 t specifically produced the highest median catch (156 t) with a median biomass of 818 t.

### Conclusions and Advice

Catches up to 160 t for 2013/2014 are projected to be at or below the reference exploitation rate of 0.15 and are projected to result in a decrease in biomass (Table 4). The probability that biomass would decline at this level of catch is 0.68. The underlying reason for this decline appears to be the low recruitment since 2008. The current population biomass is above the LRP of 530 t and the proposed USR (750 t).

Table 4. Harvest scenario table for SPA 4 to evaluate 2013/2014 catch levels in terms of resulting exploitation ( $e$ ), expected changes in biomass (%), probability of biomass decline, probability that after removal the stock will be above the USR, and above the LRP. These calculations assume a USR of 750 t and a LRP of 530 t. Potential catches in 2014/2015 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.

2013/2014						$Pr(e_{2014/2015} \geq 0.15)$					
Catch (t)	$e$	% Change	$Pr$ Decline	$Pr > USR$	$Pr > LRP$	0.1	0.2	0.3	0.4	0.5	0.6
80	0.07	-6.06	0.58	0.78	0.95	80	100	117	134	151	171
100	0.09	-7.80	0.60	0.75	0.94	78	98	114	130	148	168
120	0.11	-9.94	0.63	0.73	0.94	76	95	112	128	144	164
140	0.13	-12.00	0.65	0.71	0.93	74	93	109	126	142	162
160	0.15	-13.73	0.68	0.69	0.92	73	91	107	123	139	156
180	0.17	-15.55	0.70	0.67	0.91	72	90	106	121	136	154
200	0.19	-17.86	0.73	0.65	0.90	70	88	103	118	133	150
220	0.21	-18.95	0.74	0.63	0.89	68	86	101	115	131	148

## SPA 5 – Annapolis Basin

### Fishery

The fishery in the Annapolis Basin (SPA 5) is only open to the Full Bay Fleet with the fishing season occurring between January 1 and March 31. In recent years, landings have varied between 5.7 and 10 t (Figure 6). Total landings in 2013 were 5.7 t against a TAC of 10 t.

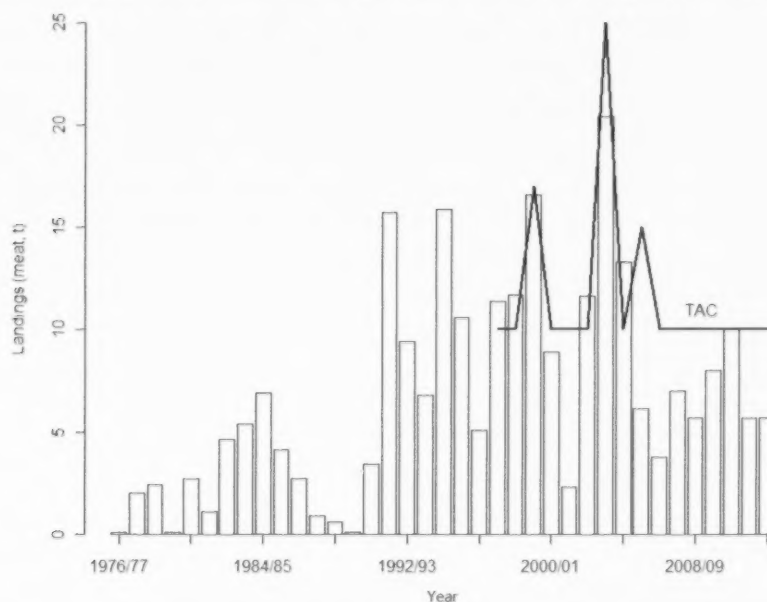


Figure 6. SPA 5 landings (meats, tons) by the Full Bay Fleet. TAC is indicated by the black line.

### Assessment

Commercial catch rate (19.7 kg/h) increased from 2012, and is above the long-term median (18.6 kg/h). Effort in this area decreased by about 400 hours and is just below the long-term median of 375 hours.



The annual survey was discontinued as of 2009 in this SPA, and the sampling effort was redirected to the other areas in the Bay of Fundy

### Conclusions and Advice

The commercial catch rate is now just above the long-term median. Since 2006/2007, the average annual catch has been 6.5 t and the average catch rate has been 16.1 kg/h.

Reference points and TAC advice have not been developed for SPA 5 because this area will be managed with SPA 4 starting with the 2013/2014 fishing season.

## SPA 6 – Grand Manan and Southwest New Brunswick

### Fishery

The areas around Grand Manan and off southwest New Brunswick are designated as SPA 6. This area is further divided into subareas 6A, 6B, 6C, and 6D (Appendix 1). Total landings for Full Bay and Mid Bay fleets in the 2013 fishing season were 125.6 t against a TAC of 140 t (Figure 6). These represent the highest landings in this area since 2001. Landings in 2012 were the lowest in the series, mainly due to very low condition of the scallops at the time of the fishery. For both of the fleets, a large proportion (e.g., 42-57% in 2013) of the catch usually comes out of SPA 6C. In 2013, close to 15 t of the catch in 6C came from Friar's Bay in Campobello Island whereas only just under 2 t was reported from there in 2012.

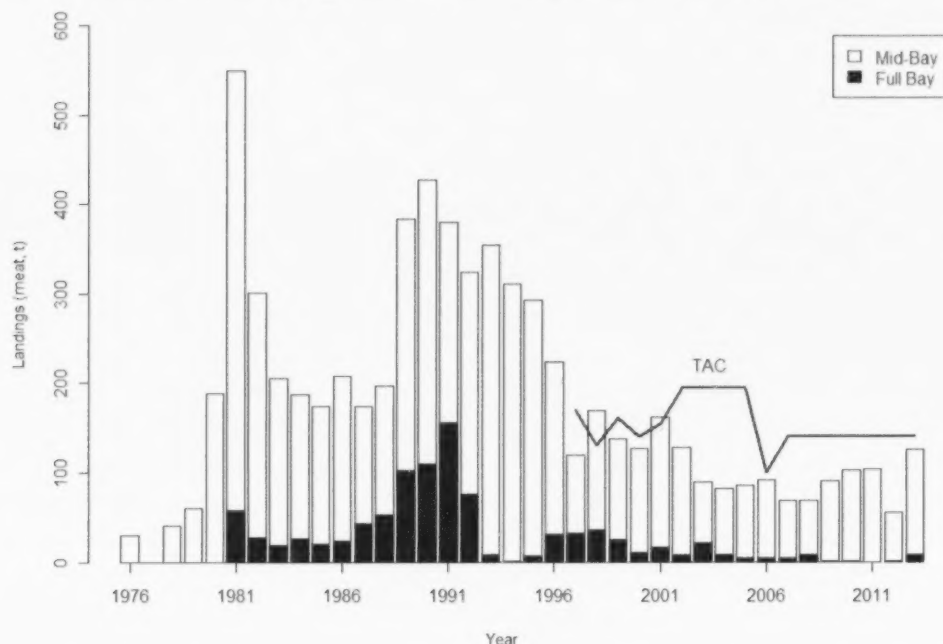


Figure 7. SPA 6 landings (meats, tons) by the Full Bay Fleet (black) and Mid Bay Fleet (white). Combined TAC is indicated by the black line.

Each year, DFO Science Scallop Unit staff validates the commercial logbook database for all scallop fisheries with respect to information on catch, effort and location by comparing the data entries with the actual logbooks filled out by the fishermen. Corrections are routinely passed to DFO's Commercial Data Division so that they can correct the database. However, at present, Commercial Data Division staff is behind in making many of these changes, most of which have been identified as being for SPA 6. While the total catch recorded in the logbooks is close to the

total in the Quota Monitoring report, there are a large number of records currently marked as having unknown subarea in the database that are not included in the Quota Monitoring report. In addition, many of the records that Science has identified as Grey Zone are still marked as 6A in the database. Assuming that all of the Science edits to the database are accepted, the overall total landings are expected to be very similar to the current amount but there will be differences in the landings by subarea.

### Assessment

Catch rates for the Mid Bay Fleet (representing the highest proportion of the catch in recent years) increased in all subareas of SPA 6 relative to the lower than average rates in 2012. In 6A, catch rates increased from 5 to 12.4 kg/h, in 6B from 6.3 to 15.4 kg/h, in 6C from 6.8 to 16 kg/h, and in 6D from 8.9 to 17.3 kg/h. Catch appears to be a linear function of effort in all subareas since 2003, suggesting that the current level of effort has resulted in an equilibrium situation where recruitment and growth balance removals from fishing and natural mortality.

Condition in SPA 6 increased in 2013 for 6A and 6B, and decreased in 6C. However, 6C still has the best condition relative to other subareas of SPA 6.

Survey estimates of commercial numbers and biomass increased in both SPA 6A and 6B in 2013, but showed no change in 6C. Abundance of recruits increased in all subareas, and pre-recruits were observed in all subareas.

### Conclusions and Advice

The TACs set in this area since 1997 have varied reflecting average catch trends in recent years and were not based on an assessment model or any other indicator of productivity. The current total TAC of 140 t has been in place since 2007 while the average total catch has been 87 t. The average total catch for 1997 to 2006 was 123 t with the Mid Bay fleet averaging 106 t. However, average catch rates during those years was almost half of the 2013 rate (8.6 vs. 16.0 kg/h).

Catch and effort trends since 2003 for this area suggest that at the current exploitation level (i.e., mean effort levels), population numbers are close to equilibrium levels with biomass fluctuations subject more to changes in condition than to overall increases or decreases in numbers. It is not known if this equilibrium corresponds to a maximum catch situation. Evidence suggests that the increases in condition associated with the 2013 catch rates were much higher than usual and catch rates may be closer to average in 2014 based on trends observed in the 2013 surveys and the fall fisheries in the other SPAs.

The commercial catch rate series starting in 1997 has been proposed as the stock status indicator for this area. The lowest catch rate in the series of 6.2 kg/hr (1997) has been proposed as the LRP for SPA 6. The development of Harvest Control Rules (HCR) for this SPA will need to incorporate the impact of changes in condition on catch rate that may not reflect changes in abundance such as observed in 2012.

### Sources of Uncertainty

Forecasts of biomass for 2013/2014 and 2014/2015 require estimates of expected biomass growth (and condition) and natural mortality for future years. These estimates are based on current conditions and, therefore, may not reflect actual changes over the next two years.

Estimates of growth and condition are based on survey to survey differences and do not explicitly account for seasonal increases or decreases between surveys. This may be part of the explanation for model underestimates (or overestimates) and should be investigated further.

In some SPAs (e.g. SPA 4), some near shore areas that are currently being fished are not covered by the survey. The impact of this on the assessment will need to be investigated further.

The evaluation of potential USRs are based on strong assumptions about recruitment and are meant to illustrate how a HCR can make relative improvements to long-term median catch levels and are not intended to predict actual biomass and catch. The projections assumed median recruitment due to the lack of evidence for stock/recruitment relationships. This is a strong assumption for the recruitment dynamics as it implies strong density dependence and does not take into account potential changes in recruitment at very low or very high stock sizes. Research on recruitment dynamics for scallops is needed before this approach can be improved upon.

## OTHER CONSIDERATIONS

Landed recreational and Food Social and Ceremonial (FSC) catch by dip netting, diving, tongs, and hand-held tools is currently not available. There were no fishery At-Sea Observer trips in the Bay of Fundy scallop fishery in 2012/2013. Refer to Sameoto and Glass (2012) for past analysis of discards from the inshore scallop fishery. As part of the requirements for Marine Stewardship Council certification of the Full Bay sea scallop fishery, the Full Bay Fleet is developing a by-catch monitoring program. A pilot for this program is to take place in SFA 29 west of 65°30' in 2014.

## SOURCES OF INFORMATION

This Science Advisory Report is from the November 6-7, 2013 Assessment of Bay of Fundy Scallop. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

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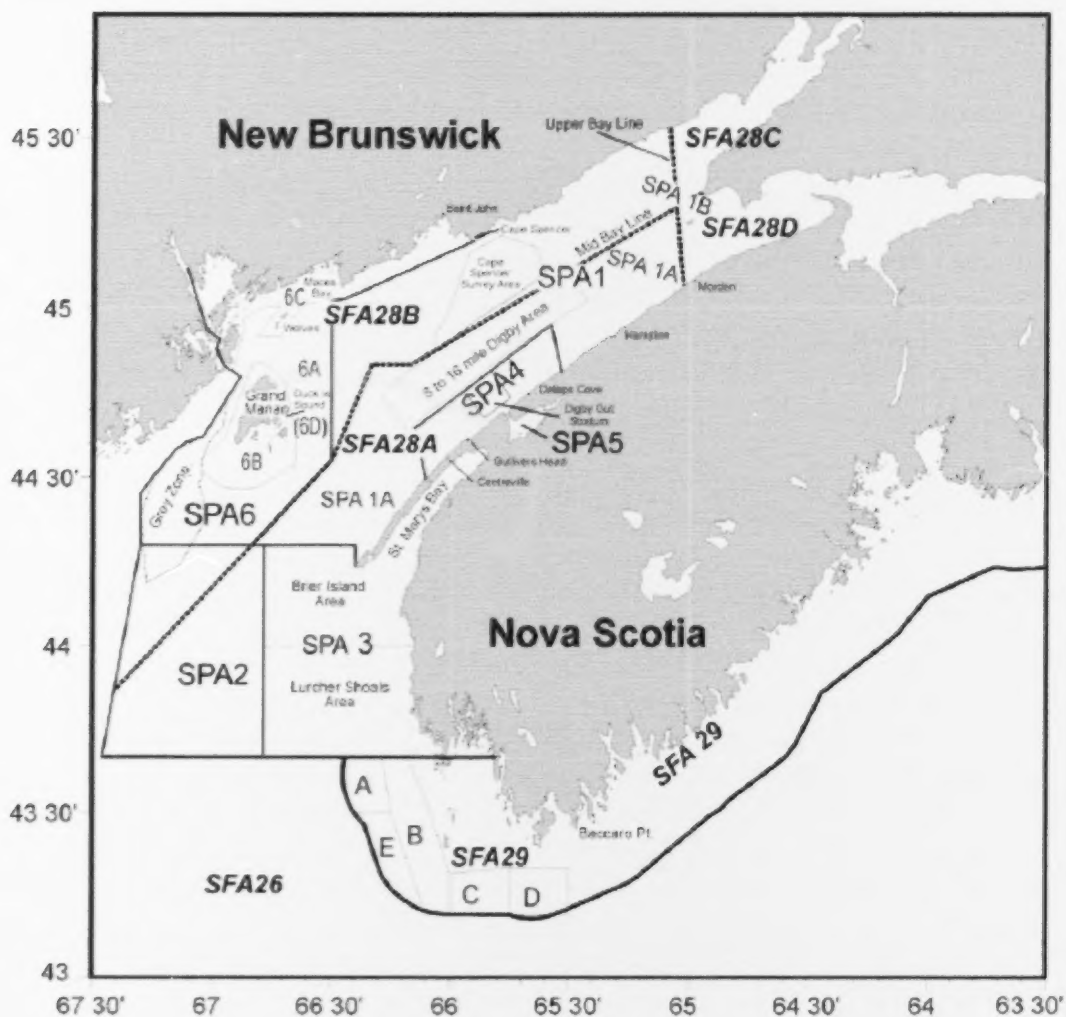
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## APPENDIX 1

Map showing the locations and place names for inshore scallop grounds.



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MPO. 2014. Évaluation des stocks de pétoncles (*Placopecten magellanicus*) des zones de production de pétoncles 1 à 6 de la baie de Fundy. Secr. can. de consult. sci. du MPO, Avis sci. 2014/018.